SDO Update

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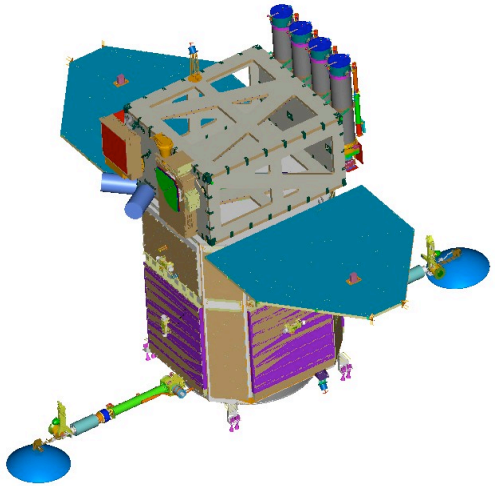
Project Scientist

Outline

- Introduction
- Spacecraft
- Instruments
- E/PO
- Schedule
- What's Left

Solar Dynamics Observatory

The First Space Weather Research Network Mission in NASA's Living With A Star Program



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Key Technologies
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Science Investigations

Helioseismic and Magnetic Imager (HMI)

PI: Phil Scherrer, Stanford University

Images the Sun's helioseismic, longitudinal and vector magnetic fields to understand the Sun's interior and magnetic activity

EUV Variability Experiment (EVE)

PI: Tom Woods, University of Colorado

Measures the solar extreme ultraviolet (EUV) spectral irradiance to understand variations on the timescales which influence Earth's climate and near-Earth space

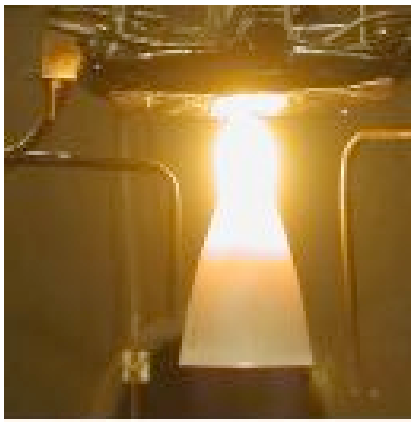
Atmospheric Imaging Assembly (AIA)

PI: Alan Title, Lockheed Martin Solar Astrophysics Laboratory

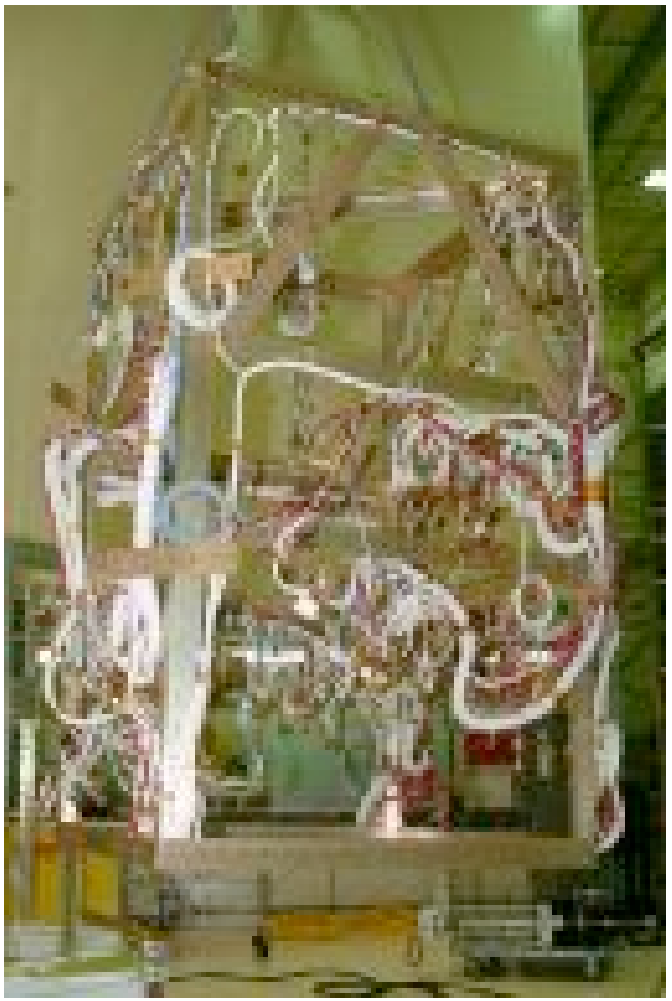
Images the solar atmosphere in multiple wavelengths to link changes to surface & interior changes

Spacecraft

- SDO is building flight hardware.
- Every subsystem is also building the test units that are used to verify the design and workmanship.
- The harness is being moved onto the flight structure.
- The propulsion system has solved several problems and is moving along
- The Ka transmitter is not yet complete.



Spacecraft



Above: Oxidizer and fuel tanks ready to go.

Right:Wiring harness ready to transfer to the flight bus.

MOC Development Status

- The DDS has been assembled and is being tested. There's 60 TBytes of storage here!
- The MOC is being prepared to support the Integration and Testing that starts in March of 2007. Communications between the instruments and science teams will go through the MOC.
- The 18-m antennas are being constructed and mounted at WSMR.

SDO Updates

- Solar cycle 24 is arriving late, SDO will launch into solar minimum conditions.
- EVE: Calibration rocket carrying MEGS and ESP instruments is scheduled for October 24. Rocket MEGS was calibrated at SURF-III in September.
- HMI: Paper describing the vector magnetogram inversion technique is in press. A second, much faster algorithm is also being developed. Data from Solar-B will be used for testing. JSOC room is built and being prepared.
- AIA: Calibration analysis is being developed with EVE. Will be tested with TIMED/SEE and SoHO/EIT. T&C room is being constructed.

SDO Updates

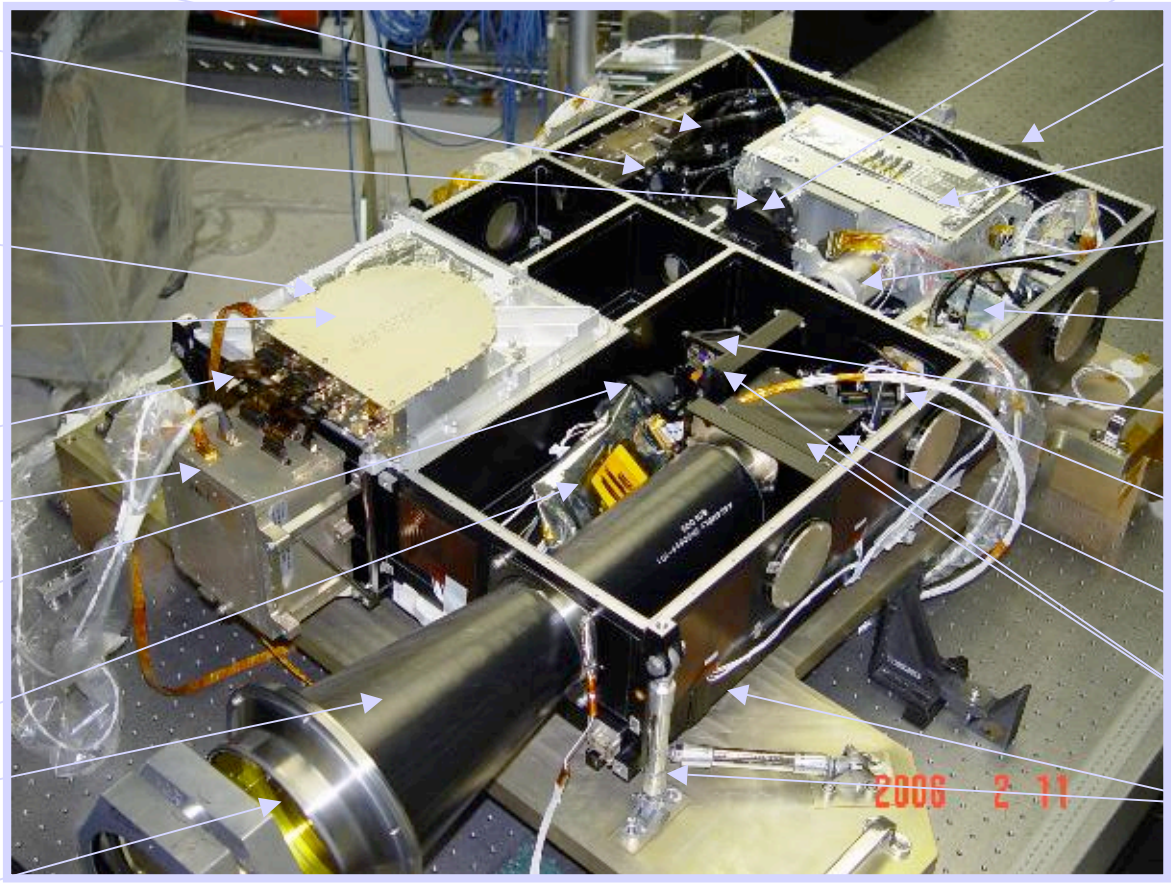
- HMI had to re-align the Lyot
- AIA had to recoat two mirrors
- C/NOFS measurements will overlap SDO

- Nothing that doesn't work—just the usual problems of building a complicated spacecraft. This is why we have slack in the schedule and reserve in the budget.

SDO Instruments

- HMI: Helioseismic Magnetic Imager, combines rotating polarizers with Michelson Interferometers to measure the intensity of the Fe I 6173 line at several wavelengths and polarization states. Produces Dopplergrams and Vector Magnetograms.
- EVE: Extreme ultraviolet Variability Experiment, measures the solar EUV spectral irradiance between 0.1 and 122 nm. MEGS-A is a glancing-incidence spectrograph, MEGS-B is a double-bounce spectrograph, ESP uses radiometers. Produces EUV spectral irradiances.
- AIA: Atmospheric Imaging Assembly, four telescopes that image the Sun in 10 bandpasses. Transmission filters and mirror coatings are combined to produce narrow-band filters. Produces radiance images that can be combined to form temperature maps of the lower corona.

HMI Optics Package



Internal Harness

BDS Fold Mirror

BDS Beamsplitter

CCD Fold Mirror

Detector Assembly

Flex-Cables

CEB
(DM1 in use for CIF testing)

Limb Sensor

Limb Pre-amp Box

Telescope

Front Window

Shutters

Alignment Mechanism

Oven Assembly

Lyot filter

Oven Controller

ISS Beam Splitter

ISS Mirror

Polarization Selector

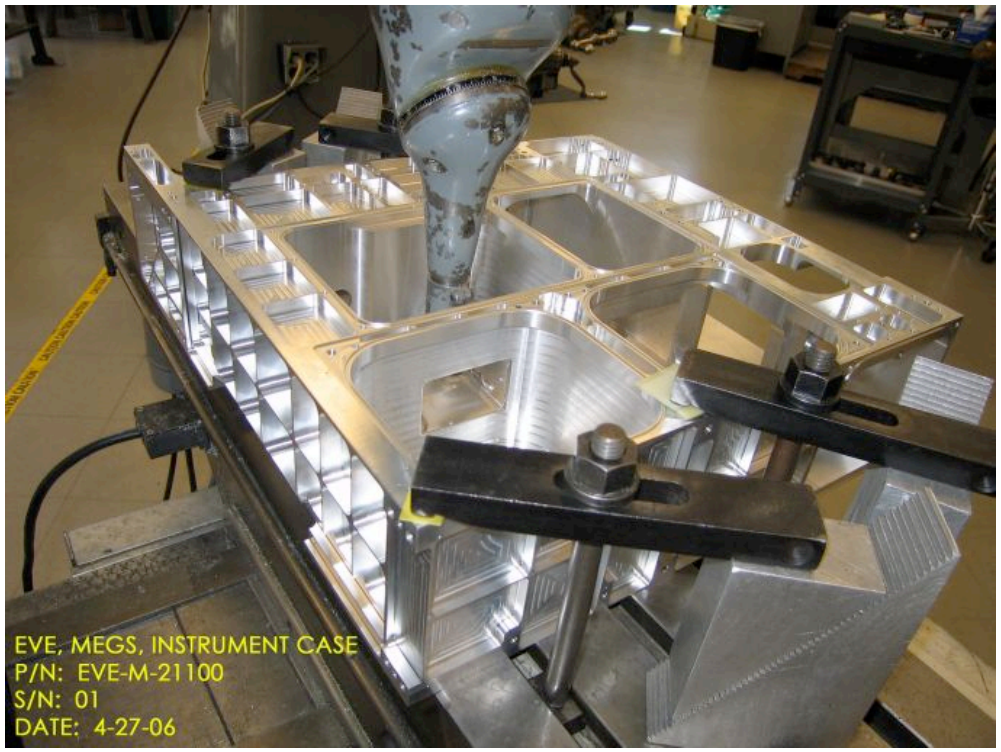
Focus/Cal Wheels

Structure
W/ legs and heaters

Optics Package Assembly

Calibration fall 2006

EVE Flight Hardware

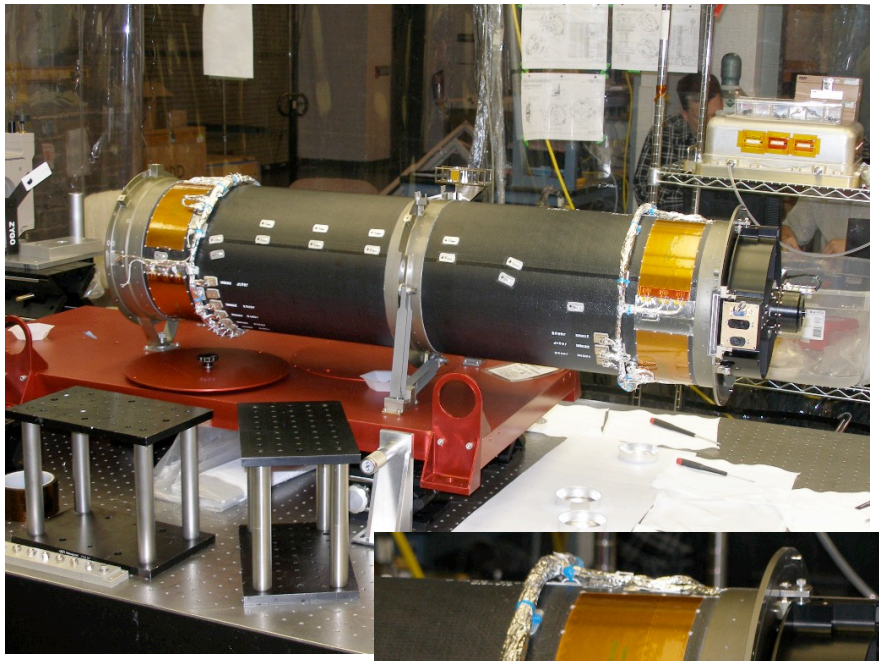


The MEGS case was excavated from a block of aluminum.

The EVE rocket instruments were calibrated at SURF in Gaithersburg, MD. ESP was at SURF in March.

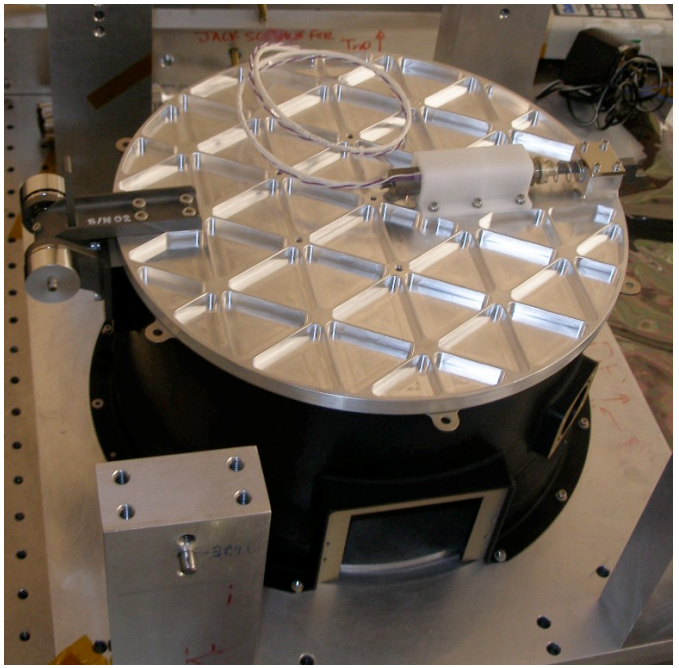
Launch on a Black Brant in October

AIA Flight Telescopes

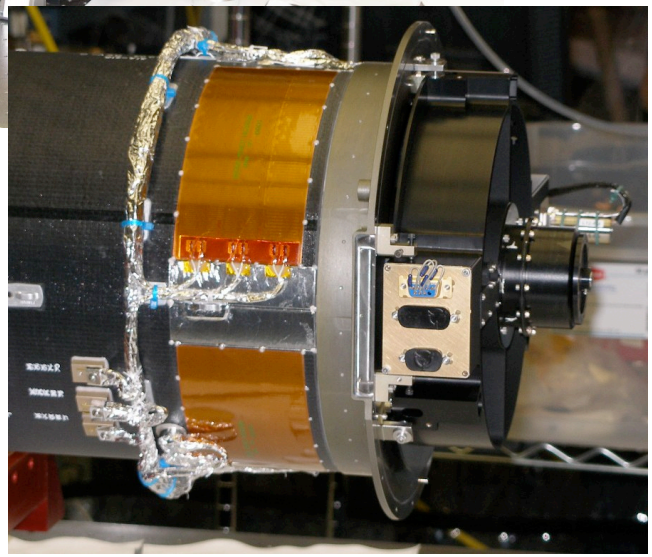


Telescope #2, Fe XIV 211 & Fe XII/XIV 193, under construction; #3 is delivered; #4 being built.

Detail of front door



Detail of spider



SOC Development Status

- The EVE SOC and the AIA/HMI JSOC have been approved and both are being built
- Command & telemetry through the MOC is will be complete by next April.
- Prototypes of JSOC hardware are being exercised
- High-Speed Bus (HSB) test is still planned
- The planned processing pipelines will be built and running prior to launch. We plan a 72-day, end-to-end test of most components 6 months before launch (1st Q 2008 with the current launch date of August 2008.)

Science Working Group

The SDO Science Working Group will meet next in Boulder just before the LWS 1 Workshop in November 2007.

Various working groups are interacting and setting up the higher-level analyses.

Instrument book containing descriptions of the instruments and their calibration is planned for soon after launch. That will be followed by a first results book 18-24 months after launch.

An article describing the vector magnetogram algorithm is in press.

E/PO

Emilie Drobnes, our E/PO lead, has been working with museums, schools, the Science Teams, and Goddard's PAO to keep SDO and solar science in the public eye.

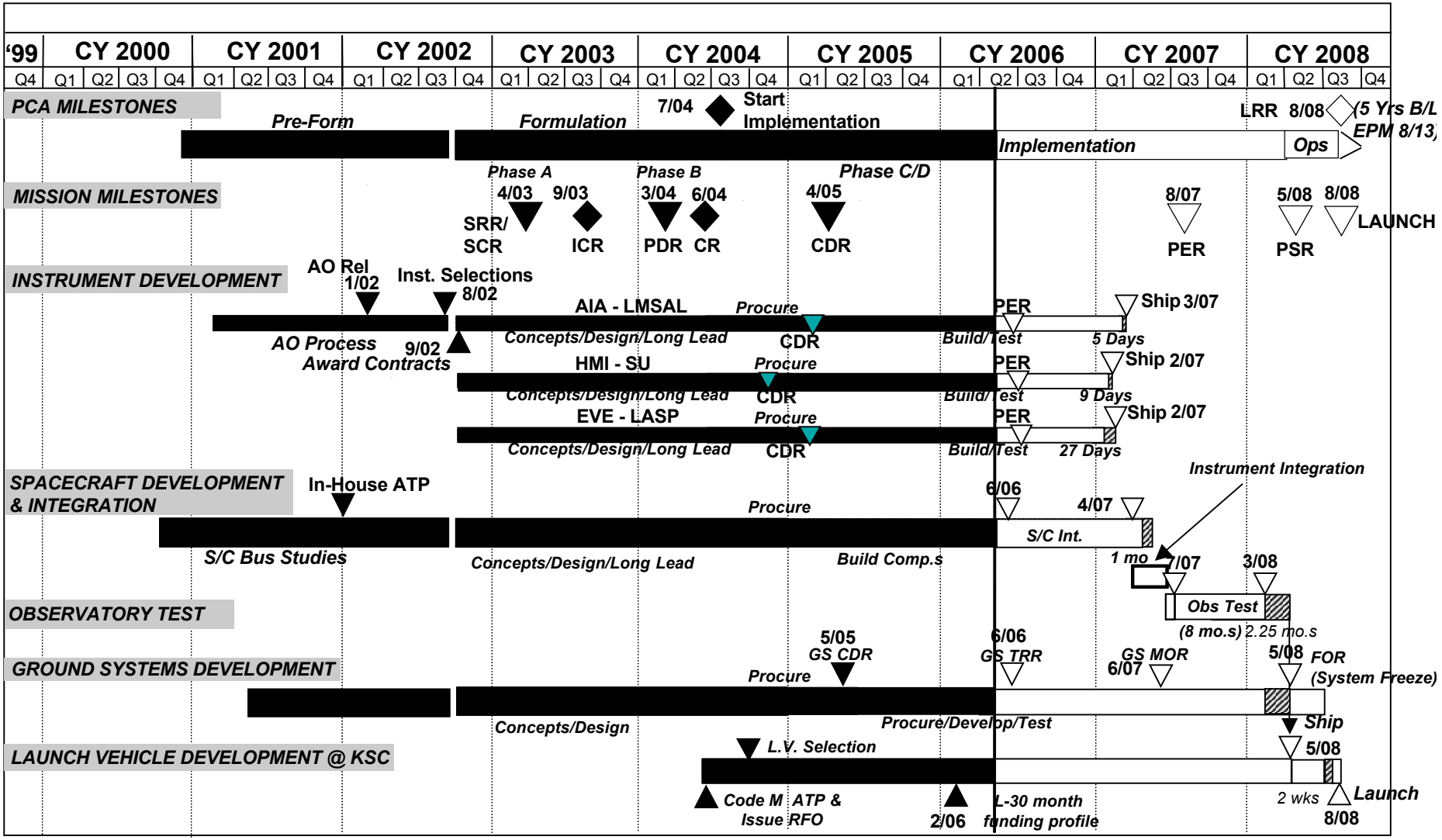
Web site has been reworked, with an E/PO site in place.

Science writers are coming to GSFC in late October to look at SDO and develop background information.

Science teachers from the DC metro area are attending a series of science workshops to learn how to work SDO science into their classrooms.

Family science nights are being held, emphasizing home-schooled students.

SDO Summary Schedule



As of: May, 2006

Legend: Original Date | Original Date | Progress Bar | Schedule Reserve (S/C 3.25 months, GS 2 months)

SU=Stanford University LMSAL= Lockheed Martin Solar Astrophysics Laboratory LASP= Laboratory For Atmospheric and Space Physics

What's Left?

A satellite is designed and built over a number of years. The SDO Science Definition Team report was released in October 2001 and the AO for SDO in early 2002. Since the instruments were selected the science we can do with SDO data has increased. Models of the solar convection zone have improved; our understanding of the response of the Earth's ionosphere to the Sun has benefited from the SEE data; quantitative interpretations of solar EUV images have begun to appear.

SDO Science Teams could not anticipate what would happen since they designed their investigations.

Further R&A support is required to analyze the SDO data and obtain the full scientific return of the mission.

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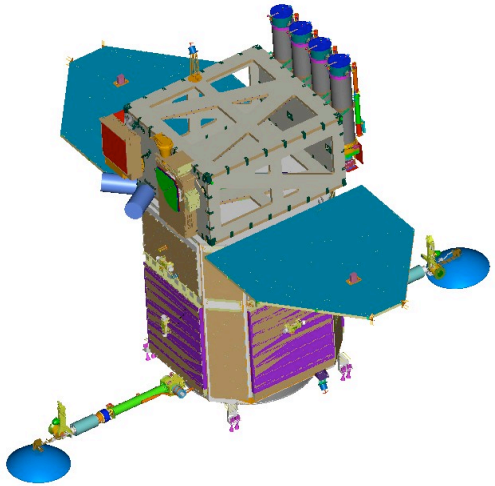

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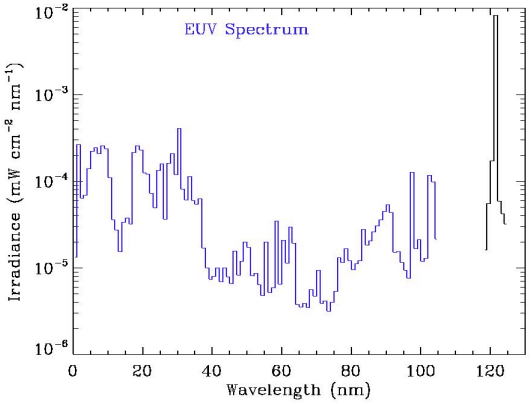
What Do We Get?

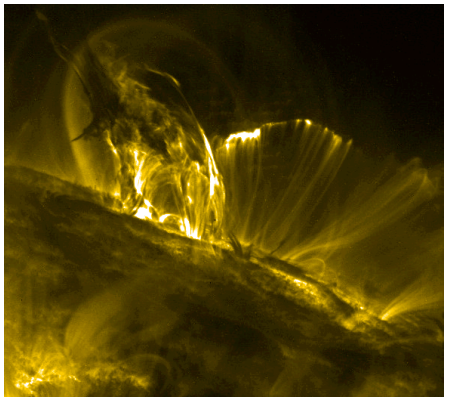
- Science studies of the Sun
  - Internal structure
  - Convection modeling
  - Magnetic dynamo
- Synergistic data for Living With a Star research
  - solar inputs to the heliosphere and ionosphere (Sentinels and ITSP)
  - Space Weather information
  - Predictions of solar activity at Earth, Moon, and other planets
- Data for other researchers

Data Products

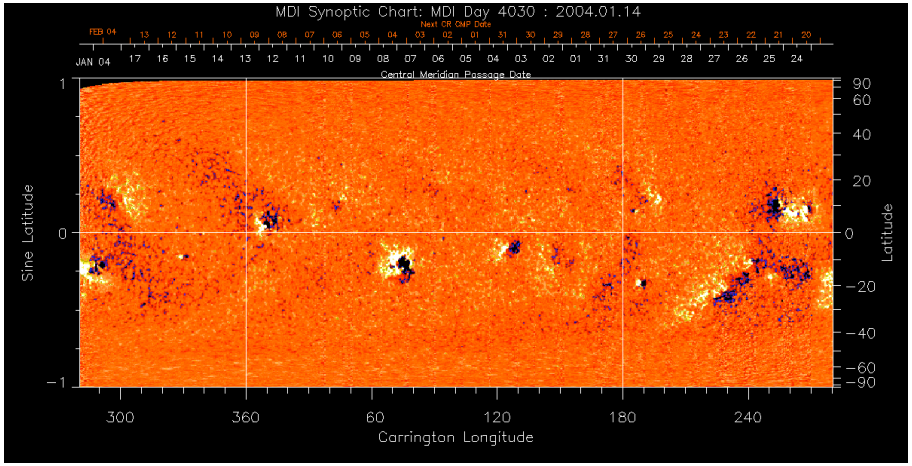
The SDO instruments will produce a set of basic data at a rapid cadence that are sent to the ground for analysis. There are few observing modes. You observe in the data base.



EUV Spectral Irradiance (10 sec)



EUV/UV Images (8 sec)



Longitudinal Magnetograms (50 sec; Vector 10 min.)

Dopplergrams (50 sec)

Data Access

- The science teams on SDO are committed to the open data policy espoused by LWS
- Their previous data sets supported by NASA, such as SOHO/MDI, Trace, and TIMED/SEE, have been freely available
- Some of the pipeline software is based on the previous missions but requires adaptation to the new file systems, size of data sets, and cadence
- Data is served by the Science Operations Centers, located at each Science Team's institution
  - HMI/AIA use a JSOC, with data at Stanford and T&C at LMSAL

Budgets

SDO is a cost-capped mission. This includes

Building the spacecraft, instruments, and ground system;

Running the spacecraft and ground system at GSFC;

Running the instruments at the SOCs;

Accepting, analyzing and serving the science by the SOCs.